

CIRCUIT CODE FOR FIG. 2A, ISSUE 2. (UNITS T4 T5)					
CODE NO.	INDUCTANCES	CODE NO.	CONDENSERS	CODE NO.	RESISTANCES
L1	AERIAL COIL, UNIT T4	C1	5 PLATE AIR TRIMMER UNIT T4 (AERIAL TUNING)	R1	50 OHMS 1/4 WATT UNIT T4
L2	AERIAL COIL, UNIT T5	C1	5 PLATE AIR TRIMMER UNIT T5	R2	100 OHMS 1/4 WATT UNIT T5
L3	OSCILLATOR, UNIT T5	C2	SPLIT STATOR CONDENSER	R3	100 OHMS 1/4 WATT
L4	OSCILLATOR, UNIT T4	C3	1000 MMFD 350V. MICA	R4	7000 OHMS 1/4 WATT
L5	COUPLING COIL	C4	100 MMFD 350V. MICA	R5	2000 OHMS 1/4 WATT
L6	RF. CHOKE	C5	1000 MMFD 350V. MICA	R6	100 OHMS 1/4 WATT UNIT T4
L7	RF. CHOKE	C6	100 MMFD 350V. MICA	R7	150 OHMS 1/4 WATT UNIT T5
L8	IF. COIL	C7	20 MMFD 350V. MICA	R8	25,000 OHMS 1/4 WATT
L9	RF. CHOKE	C8	100 MMFD 350V. MICA	R9	100 OHMS 1/2 WATT
L10	PLATE CHOKE	C9	1000 MMFD 350V. MICA	R10	20,000 OHMS 1/2 WATT
L11	IF. COIL	C10	100 MMFD 350V. MICA	R11	1000 OHMS 1/4 WATT
L12	RF. CHOKE	C11	100 MMFD MICA COND. CENT.	R12	1000 OHMS 1/4 WATT
L13	PLATE CHOKE	C12	1000 MMFD 350 V. MICA.	R13	30 OHMS 1/2 WATT
L14	IF. COIL	C13	1000 MMFD 350 V. MICA.	R14	150 OHMS 1/4 WATT
L15	RF. CHOKE	C14	1000 MMFD 350 V. MICA.	R15	1000 OHMS 1/4 WATT
L16	PLATE CHOKE	C15	1000 MMFD 350 V. MICA.	R16	400 OHMS W.W. POT. ("GAIN")
L17	IF. COIL	C16	VARIABLE 9 PLATE	R17	1000 OHMS 1/4 WATT
L18	RF. CHOKE	C17	1000 MMFD 350 V. MICA	R18	250 OHMS W.W. POT. (PRESET)
L19	RF. CHOKE	C18	1000 MMFD 350 V. MICA	R19	1000 OHMS 1/4 WATT
L20	IF. COIL	C19	1000 MMFD 350 V. MICA	R20	30 OHMS 1/2 WATT
L21	RF. CHOKE	C20	1000 MMFD 350 V. MICA	R21	150 OHMS 1/4 WATT
		C21	100 MMFD MICA COND. CENT.	R22	10,000 OHMS 8 WATT
		C22	1000 MMFD 350 V. MICA	R23	1000 OHMS 1/4 WATT
		C23	1000 MMFD 350 V. MICA	R24	5000 OHMS 8 WATT
		C24	VARIABLE 9 PLATE	R25	1000 OHMS 1/4 WATT
		C25	1000 MMFD 350 V. MICA	R26	1000 OHMS 1/2 WATT
		C26	1000 MMFD 350 V. MICA	R27	30 OHMS 1/2 WATT
		C27	1000 MMFD 350 V. MICA	R28	150 OHMS 1/4 WATT
		C28	100 MMFD MICA CENTRALAB	R29	1000 OHMS 1/4 WATT
		C29	1000 MMFD 350 V. MICA	R30	50 OHMS 1/4 WATT
		C30	1000 MMFD 350 V. MICA	R31	300,000 OHMS 1 WATT
		C31	1000 MMFD 350 V. MICA	R32	5 OHMS W.W. *
		C32	VARIABLE 9 PLATE	R33	10 OHMS W.W. *
		C33	1000 MMFD 350 V. MICA	R34	10 OHMS W.W. *
		C34	1000 MMFD 350 V. MICA	R35	10 OHMS W.W. *
		C35	1000 MMFD 350 V. MICA	R36	30 OHMS W.W. *
		C36	1000 MMFD 350 V. MICA	R37	250 OHMS 1/2 WATT
		C37	100 MMFD MICA CENTRALAB	R38	1000 OHMS 1/4 WATT
		C38	VARIABLE 9 PLATE	R39	1000 OHMS 1/4 WATT
		C39	1000 MMFD 350 V. MICA	R40	50,000 OHMS 1/4 WATT
		C40	1000 MMFD 350 V. MICA	R41	1000 OHMS 1/4 WATT
		C41	1000 MMFD 350 V. MICA	R42	40,000 OHMS 1/2 WATT
		C42	1000 MMFD 350 V. MICA	R43	25,000 OHMS POT. (PRESET)
		C43	1000 MMFD 350 V. MICA	R44	7000 OHMS 1/2 WATT
		C44	1000 MMFD 350 V. MICA	R45	500 OHMS 1/4 WATT
		C45	1000 MMFD 350 V. MICA	R46	2000 OHMS 1/4 WATT
		C46	1000 MMFD 350 V. MICA	R47	5000 OHMS 1/2 WATT
		C47	VARIABLE 9 PLATE	R48	5000 OHMS 1/4 WATT
		C48	1000 MMFD 350 V. MICA	R49	5000 OHMS 1/4 WATT
		C49	1000 MMFD 350 V. MICA	R50	2000 OHMS 1/4 WATT
		C50	1000 MMFD 350 V. MICA	R51	10,000 OHMS 1/4 WATT
		C51	1000 MMFD 350 V. MICA	R52	50 OHMS 1/4 WATT
		C52	5 MFD 400 V. COND.		
		C53	1 MFD 400 V. COND.		
		C54	50 MMFD 350 V. MICA		
		C55	1000 MMFD 350 V. MICA		

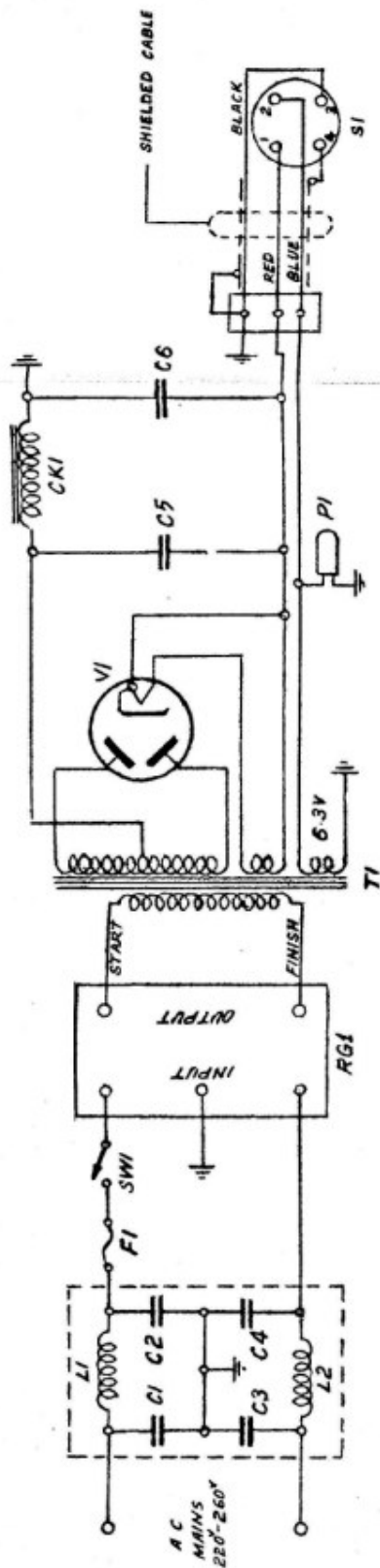
CODE NO.	MISCELLANEOUS
J1	JACK, TELE.SWBD.TYPE 2 CONDUCTOR.
M1	MILLIAMMETER,K.475, 0-1 PATON ELECTRIC.
P1	CONNECTOR, - 4 PIN: W150
S1	SWITCH, 2 POLE 11 POSITION GANGED - YAXLEY. ("METER")
S2	SWITCH, 2 POLE 2 POSITION GANGED - YAXLEY ("AVC - MANUAL")
TL1	TRANSMISSION LINE, 80 OHMS LEAD COVERED POLYTHENE FTIL.
A	93C AMPHENOL CONNECTOR

FIG 2B

CXS 51.

ISSUE	1.
APPROVED	2.

ISSUE APPROVED
1. H.R.G.



A.C. POWER PACK FOR FIELD STRENGTH UNITS (T4, T5 & T6)

STOCK LIST

ITEM	DESCRIPTION	ITEM	DESCRIPTION
C1	100 μ F 350 V. WKG. COND MICA	VI	VALVE 5V4G
C2	" " " " " "	SI	4 PIN SOCKET (ENGLISH TYPE W150)
C3	" " " " " "	SWI	TOGGLE SWITCH
C4	" " " " " "	PI	6.3V. 3A. PILOT LAMP
C5	5 μ F. 400 V. " " CHANEX PAPER	RG1	'A.W.A.' REGULATOR UNIT (TYPE XB 8161)
C6	" " " " " "	FI	FUSE AUSTRALUX 5 AMP
CK	POWER CHOKE		
T1	" TRANSFORMER		
L1	U.H.F. COIL		
L2	" " " "		

R.A.F. TESTING EQUIPMENT.
DESCRIPTION OF CALIBRATOR UNIT.

R.D.F. TESTING EQUIPMENT.

DESCRIPTION OF CALIBRATOR UNIT.

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Table 1	

Diagrams Fig. 1A

CALIBRATOR UNIT

Service Designation
P.M.C. Unit T.17

Calibrator, Range Type MP (Aust)

R.A.N. - Patt. No. (Aust) 227

A.M.F. -

R.A.N.F. - Test set type A5
YLOS/60005

Serial No. -

FUNCTIONS

- (1) Pulse repetition frequency meter. (Calibrated 300-800 C/s.)
- (2) Time base calibrator.
 - A. Gives R.D.F. range "pips" 0, 1, 2, 3, 4, 5, 6, 7, 8 and 9 nautical miles.
 - B. Gives R.D.F. range "pips" 0, 4, 8, 12, 16, 20, 24, 28, 32 and 36 nautical miles.
 - C. Gives R.D.F. range "pips" 0, 10, 20, 30, 40, 50, 60, 70, 80 and 90 nautical miles.

SPECIFIC TICK (Pulse repetition frequency meter)

- (1) Calibrated range 300-800 cycles per second.
- (2) Positive pulse input through coaxial connector. Magnitude at least 50 volts peak.
- (3) Display - Direct current meter.
- (4) Power supply - From time base calibrator supply.
- (5) Controls.
 - A. "Check" - "Read" switch.
 - B. "Check" adjusting potentiometer.
 - C. Preset potentiometer. (Under chassis adjustment).
- (6) Valves
 - A. 6H6 - one off

SPECIFICATION (Time base calibrator)

- (1) See Functions (Section 2) above.
- (2) Input - Negative pulse through coaxial connector.
- (3) Output - Positive "pips" as described, taken through coaxial connector and cable to either input of the indicator unit, from which the receiver output is disconnected.
- (4) Power supply - 80 volts, 800-2400 cycles.
- (5) Controls
 - A. Range selector - 3 position switch selecting 10, 40 or 100 mile ranges

B. Gain control

C. Power on-off switch.

(6). Valves

6V6G - - 1 off

1852 - - 2 off

6H6 - - 1 off

5V4G - - 1 off

REFERENCES

Circuit and Code (Figures 1A and 1B)

INTRODUCTION

The Calibrator is a unit, which will perform two separate functions:

- (1) Calibration of the A.S.V. range scale over three ranges, namely, 10, 40 and 100 miles.
- (2) Measurement of the repetition frequency of the A.S.V. transmitter.

It can be put to similar uses on similar equipment within the limits outlined in this description. The calibrator is triggered by a negative pulse from the transmitter, and produces a series of calibrating "pips" or pulses as described. The output is connected to the Indicator Unit, where the "pips" are displayed on the C.R. Oscillograph screen, and the time base of the oscillograph can be adjusted so that the scale indicates accurately in miles.

The Repetition Frequency Meter takes a positive pulse from the transmitter, and indicates the frequency directly on a calibrated meter.

DESCRIPTION (Frequency Meter only)

Referring to Tube V1 of Figure 1 a positive pulse of 50 volts peak charges C_1 after passing through the series diode, D_1 of the 6H6. The pulse usually only lasts a few microseconds and then drops to zero. As it drops to zero P_2 drops to earth potential so that C_1 cannot discharge via D_1 . It can only discharge through VR_2 and R_2 in parallel (switch S_2 in lower position), and its discharge will be exponential from 50 volts with a time constant determined by C_1 and VR_2 and R_2 in parallel. This time constant is approximately 100 microseconds, so that the condenser will discharge to 1 volt (virtually discharged) in approximately 400 microseconds. Hence for repetition frequencies up to at least 1000 C/s. (period 1000 microseconds) C_1 completely discharges before the next pulse comes along. Then it is obvious that for repetition frequencies up to 1000 C/s. the average voltage (as registered on a direct current meter) is directly proportional to frequency. R_2 and M_1 act as a voltmeter to measure the average voltage across C_1 . The calibration of the meter is usually done by applying known repetition frequencies and marking the scale off in C/s.

Now in order to ensure that the positive pulse across

C_1 is just 50 volts, diode D_2 , biased 50 volts negative is shunted across C_1 . When the applied pulse at P_2 is greater than 50 volts positive, diode D_2 offers a low impedance and prevents the volts across C_1 from rising above 50. The 50 volts negative bias for the diode is obtained by tapping a positive voltage off the voltage divider R_{19} , and further splitting this up by means of a potentiometer VR_1 before applying to the cathode of the diode. This voltage is adjusted to just 50 volts by throwing switch S_2 up, so that R_1 and M_1 act as a voltmeter across this negative bias, and VR_1 is varied until the pointer indicates on a mark on the voltmeter corresponding to 50 volts. That the applied positive pulse is not less than 50 volts peak can be ascertained by throwing S_2 down to "read" position and altering the setting of VR_1 , which should alter the reading on the meter. If the meter reading does not alter it means that the bias on the diode (50 volts) is greater than the applied pulse, and the magnitude of the pulse will have to be increased before a satisfactory frequency reading can be taken.

OPERATION (Frequency Meter only).

(1) Initial adjustments

In quantity production the following procedure is adopted:

- A. Put S_2 up in "calibrate" position and adjust VR_1 until the pointer reads on the special mark on the scale of the meter. This adjusts the negative bias on D_2 to 50 volts.
- B. Apply a pulse, the repetition frequency of which is accurately known, to P_2 . Throw switch S_2 down to "read" position and vary VR_1 . This should vary the reading on the meter. If not, the pulse is not of sufficient magnitude and should be increased.
- C. Reset S_2 to "calibrate" and repeat (1).
- D. Throw S_2 down to "read" and adjust VR_2 until the meter, already marked in "frequency" indicates the value of the known calibrating frequency.
- E. Check against another known repetition frequency without altering any adjustments.

(2) Service adjustments.

In service it should be presumed that VR_2 has been correctly adjusted in manufacture and then the following procedure should be adopted:

- A. Repeat "Initial adjustment A"
- B. Throw switch down to "read" position and note the frequency reading "f". Then alter VR_1 , and if the reading on the meter varies the above noted reading "f" is the repetition frequency. If the reading does not vary, the pulse

magnitude must be increased before the frequency can be correctly read.

DESCRIPTION (Time base calibrator only)

(1) Generating valve - - - V₂ (6V6G)

Referring to Figure 1 tube V₂ has inductance L₁ and condenser C₃ in its plate circuit. This combination has a resonant frequency of 8.1 kc/s, and before a pulse arrives L₁ is passing approximately 25 W/Amps of direct current, representing a certain amount of stored energy. Then the negative pulse arrives and cuts off the plate current of the valve almost instantaneously and the inductance has no alternative but to discharge its energy into the condenser C₃, and so a damped train of oscillations is set up at the resonant frequency of L₁ and C₃. The first ten cycles of this damped oscillation (the ones in which we are interested) are reasonably constant in amplitude, but the oscillation had died away to a negligible value before the next pulse arrives. The valve is cut off only for the period of the pulse, a few microseconds, and then returns to a conducting state and awaits the next pulse. Incidentally, this restoring of conductivity sets up another damped train of oscillations of opposite phase to the first and some cancellation occurs. The period of one cycle of this damped oscillation "t" is 103 ± 123.5 microseconds, which is the time necessary for an electromagnetic wave to travel 20 nautical miles in free space, or 10 miles to an object and return. Hence if this period "t" is displayed on a C.R. Oscilloscope screen it will represent 10 nautical miles of R.D.F. range, or 9 of these periods will represent 90 miles of R.D.F. range. Accordingly, the rising positive parts of the train of oscillations are made to stand out from the remainder of the cycles, and the first ten appear as ten sharp graduations or "pips" on the C.R.O. screen, separated by "t" microseconds or 10 nautical miles of range. Two other range scales can be selected by switch S₁ (a three position switch) which merely changes to two other L.C. combinations, one of resonant frequency 20.25 kc/s. (4 mile increments) and the other 81 kc/s. (1 mile increments). This latter range has the greatest initial amplitude, because it has the greatest resonant impedance in the plate circuit. The pips are produced by the action of valves V₃ and V₄.

(2) Amplifying valve V₃ - - - 1852.

This is used primarily for the purpose of increasing the slope of voltage against time of the sine wave, in particular the rising positive parts of the sine wave nearest to the base line. The 1852 is well suited to this purpose, having a high mutual conductance.

(3) Amplifying valve V_4 - - - 1852.

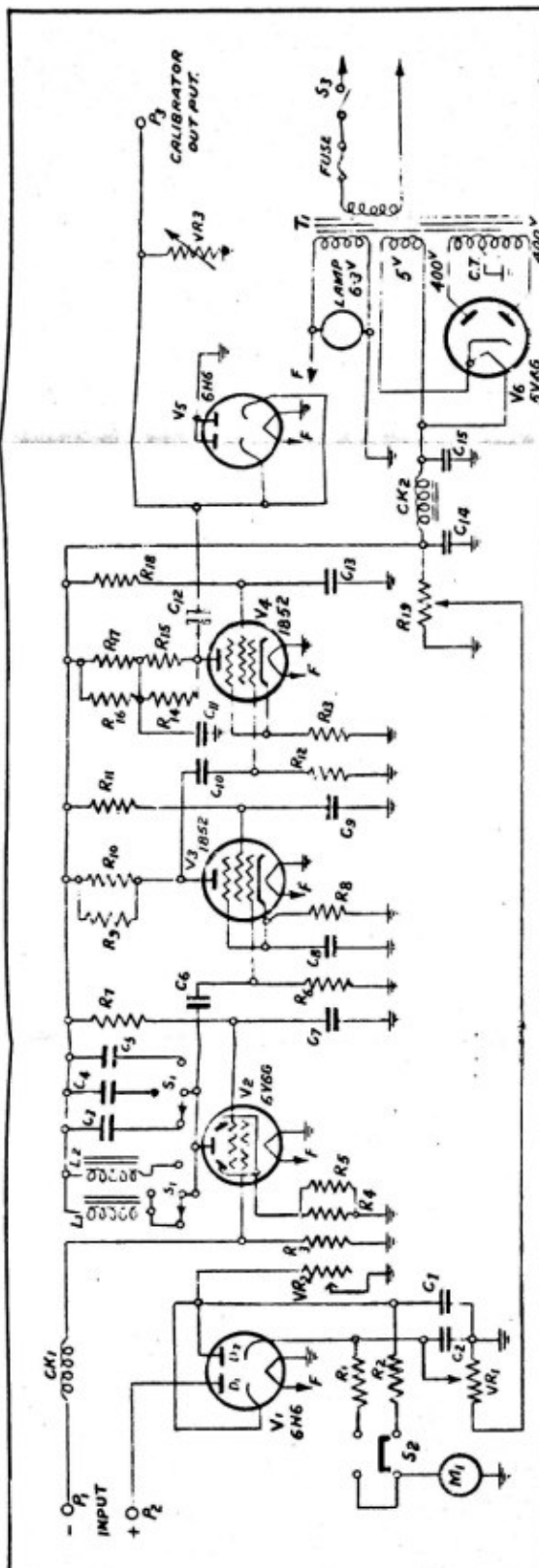
Further increases the slope of voltage against time of the sine wave, but in addition blocks off the tops of the sine waves at a level not far above the base line. If this valve had a strictly resistive plate load, the resulting output would be an approximately rectangular wave. Due to the drastically small time constant of the C_{12} , VR_2 combination, however, only the first part (rising positive) of the rectangular wave is amplified in the form of a "pip". The negative "pips" are not produced because the diode V_5 presents a low impedance to negative pips, which are, therefore, not amplified by V_4 . These positive pips, of course, are the amplified rising positive slopes of the sine wave (at the base line) at V_3 grid, and hence the first "pip" occurs at a time very nearly coincident with the applied pulse at T_1 .

OPERATION (Time base calibrator only)

(1) Voltage Analysis--See Table 1.

(2) Initial adjustments during manufacture.

- A. A standard calibrator is checked against a special Standard Test Oscillator at the three frequencies 8.1, 20.25 and 81 kC/s. by aural methods.
- B. Connect negative pulses from a pulse generator (300-500 C/s) to the negative input of the standard calibrator, and also to the calibrator under test, and connect the positive pulse from the pulse generator to "Time Base" coaxial inlet on the Indicator. Connect two power supply cables to the indicator from its power supply. Connect the standard calibrator output to one video input of the indicator unit, and connect the calibrator under test to the other video input of the indicator. Adjust the frequency of the calibrator "pips" on each range to synchronism with those of the standard calibrator by adjusting the inductance of the coils. Synchronism is obtained when the "pips" on one side of the trace cancel those on the other side, leaving the trace substantially free from pips. The range of adjustment of frequency is $\pm 3\%$. The "100" and "40" mile ranges use the same inductance so if any errors are present they should be averaged between the two ranges. The error at any range should not be greater than $\pm 2\%$, which is approximately $\pm \frac{1}{16}$ th at the 9th and 10th pips.
- C. The height of the calibrating pips on each range should be within 25% of the following -



ITEM	S.M.V.NO.	DESCRIPTION.	ITEM.	H.M.V.NO.	DESCRIPTION.	ITEM	H.M.V.NO.	DESCRIPTION.
R1.	O3X.	0.5 Megohm. 1 W.	C.11.	3005T.	.5 uF.	LAMP.	D.4216.	6V. MINIATURE SCREW.
R2.	V3X.	20,000 ohms. 1 W.	C.12.	0243BY.	10 uF.	FUSE.		TYPE 4 A.G. 5 AMP.
R3.	O3X.	0.5 Megohm. 1 W.	"	"	"	VALVE		
R4.	O3X.	2,000 ohms. 1 W.	C.13.	3005S.	.1 uF.	BASES.		
R5.	AJ7X.	"	C.14.	3005U.	2 uF.			6 OFF. OCTAL CERAMIC "AMPHENOL".
R6.	O3X.	"	"	"	"			
R7.	F3X.	15 Megohm. 1 W.	C.15.	3005T.	.5 uF.			
R8.	D3X.	10,000 ohms. 1 W.	"	"	"			
R9.	D3X.	1,000 ohms. 1 W.	T.1.	D.4008.	80V. 850-1,800 c/s TRANS.			
R10.	D3X.	250,000 ohms. 1 W.	"	"	"			
R11.	A73X.	50,000 ohms. 1 W.	CK.1.	D.4041.	R.F. CHOKE.			
R12.	O3X.	"	CK.2.	D.4009.	FILTER CHOKE 100 MA.			
R13.	F3X.	.5 Megohm. 1 W.	L.1.	D.4021.	IRON CORED CHOKE 11 mH.			
R14.	V3X.	150 ohms. 1 W.	L.2.	D.4022.	" " 3.7 mH.			
R15.	V3X.	20,000 ohms. 1 W.	S.1.	D.4200.	SWITCH 3 POLE 3 POSITION "YAXLEY".			
R16.	A73X.	"	S.2.	D.4109.	SWITCH "ALPHA" 2A. 240V. 2 WAY.			
R17.	A73X.	60,000 ohms. 1 W.	"	"	"			
R18.	A73X.	"	"	"	"			
R19.	4002.	25,000 ohms. 75 W.	I.R.C.	"	"			
C1.	O243C.	.005 uF.	"CHANEX"	"	"			
C2.	3005W.	.1 uF.	"	"	"			
C3.	O243BY.	.04 uF.	"	"	"			
C4.	O243BX.	.006 uF.	"	"	"			
C5.	O243BW.	.001 uF.	"	"	"			
C6.	O243BW.	.001 uF.	"	"	"			
C7.	3005S.	.1 uF.	"	"	"			
C8.	3005W.	.02 uF.	"	"	"			
C9.	3005S.	.1 uF.	"	"	"			
C10.	O243AG.	.00025 uF.	"	"	"			

FIG. 1A & 1B

TABLE I.

D.C. PLATE SUPPLY (B+)		340 VOLTS
FILAMENT SUPPLY.	6.3 "	
V2 CATHODE TO EARTH.	25 VOLTS ±15%.	
SCREEN " "	315 " ±15%.	
PLATE " "	340 " ±25%.	
V3 CATHODE TO EARTH.	4.5 " ±15%.	
SCREEN " "	250 " ±15%.	
PLATE " "	25 " ±15%.	
V4 CATHODE TO EARTH.	2.0 " ±15%.	
SCREEN " "	175 " ±15%.	
PLATE " "	17C " ±25%.	

R.A.F. TROOP TRAINING.

DESCRIPTION OF INTERVIEW TRAINING SET

R.D.F. TESTING EQUIPMENT.

DESCRIPTION OF DISTANCE MEASURING SET.

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IMPEDANCE MEASURING SET:

SERVICE DESIGNATION

P.M.G. Unit 7A Impedance measuring set - type A
 (Aust.)
R.A.N. -
A.M.F. - ZCA4402
R.A.A.F. - Test Set type A10
 YLOS/60018

P.M.G. Unit 7B Serial No.
 Impedance measuring set - type P
 (Aust.)
R.A.F. - Patt No. (Aust.) 203
A.M.F. -
R.A.A.F. - Test set type A3
 YLOS/60003

Serial No.

SPECIFICATION.

(1) Frequency

Type A 200 mC/s Type B 175 mC/s Type C 214 mC/s

(2) Description (all types)

Concentric transmission line with constant current input and sliding unknown.

(3) Range (all types)

- (a) Reactance 1 to 5000 ohms
(b) Resistance 1 to 5000 ohms

(4) Auxiliary Equipment

Type A Field Strength Receiver and Battery
Test Oscillator 180-220
Type B Field Strength Receiver and Battery
Test Oscillator 160-190

(5) Indication (all types)

- (a) By pointer moving over scale graduated in electrical degrees of a transmission line. (One wavelength = 360 electrical degrees);
- (b) Decibel variation of transmission line input impedance as read on output meter of Field Intensity Receiver.

(6) Computation of impedance

- (a) Resistance graphs (one sheet)
For pure resistances between 9 and 800 ohms and resistive component of complex impedances within the limits of the envelope of the graphs.
- (b) Reactance graphs (one sheet)
For the reactive component of complex impedances within the limits of the envelope of the graphs.

- (c) Conductance graphs (one sheet)
Limitations similar to resistance graphs.
 - (d) Susceptance graphs (one sheet)
Limitations similar to reactance graphs.
 - (e) Other values by computation as explained under
OPERATION and in the appendices.
- (7) Initial adjustments (initially done by manufacturer)
- (a) Input from Battery Test Oscillator (variable condenser);
 - (b) Output to Field Intensity Receiver (variable condenser);
 - (c) Variable inductance at input of transmission line to tune out stray capacities;
 - (d) Variable line (1/4 wave nominal) for similar purpose at unknown impedance.
- (8) Units T 7A and T 7B are identical except for degree scale and the inductance L.

REFERENCES.

P. M. G. Department Drawing No. CX-62, Sheets 1 to 5.

INTRODUCTION.

This instrument is designed to measure at a given ultra-high-frequency, the equivalent series resistance and reactance (inductive or capacitive) of an unknown impedance. The impedance can then be easily calculated if desired, but the reactance and resistance are usually the most desired quantities. Some of the more important applications of the instrument are:

- (1) Measurement of the impedance of aerial arrays;
- (2) Measurement of the impedance of transmission lines, coaxial cables, etc.
- (3) Measurement of dynamic impedance of tuned circuits;
- (4) Tuning of resonant circuits, which are coupled to transmission lines;
- (5) General impedance measurements at U.H.F. which are usually difficult by the conventional measuring devices.

MAINTENANCE INSTRUCTIONS.

To ensure a minimum of wear the inner conductor and inside of the outer conductor should be lubricated with colloidal graphite such as "oildag". At regular intervals, particularly in dusty localities, the set should be dismantled, cleaned and re-lubricated.

When the set is not in use the wooden cover should be replaced, otherwise dust may enter through the sides of the outer tube. There is also a tendency for personnel to lift the set by the tube and so distorting it that the slider may jam.

THIS INSTRUMENT IS TO BE HANDLED WITH EXTREME CARE.

DESCRIPTION

If a generator E is connected in series with an extremely high impedance Z_a and a normal impedance Z_{in} (figure 1) and we connect a voltmeter across Z_{in} , then

the whole represents a constant current generator of current I and the voltage V_1 across Z_{in} is equal to $I Z_{in}$. If Z_{in} is replaced by a smaller impedance z_{in} , the voltmeter now reads a voltage $v_1 = I z_{in}$.

$$\text{Therefore } \frac{V_1}{v_1} = \frac{Z_{in}}{z_{in}} = \frac{Z_{in}}{Z_{in}}$$

The ratio $\frac{V_1}{v_1}$ can be accurately obtained even at

U.H.F., and hence the ratio $\frac{Z_{in}}{z_{in}}$ is accurately known.

In the impedance measuring set Z_{in} and z_{in} are respectively the maximum and minimum input impedances of a transmission line as the unknown impedance Z_T slides along the transmission line (Fig. 2). If maximum impedance Z_{in} occurs when Z_T is $1/8$ th wavelength from input end of the transmission line, then minimum impedance z_{in} occurs when Z_T is at a point "a" $3/8$ th of a wavelength from input end, or if minimum z_{in} occurs at point A ($1/8$) then maximum occurs at point "a" ($3/8$). In general maximum and minimum impedances Z_{in} and z_{in} occur at positions of Z_T separated by exactly $1/4$ wavelength. Further, by reading this distance of Z_T from the input end of the line, which gives maximum impedance and calculating the ratio of the maximum and minimum voltmeter readings $\frac{V_1}{v_1} = \frac{Z_{in}}{z_{in}}$ we can readily calculate

the series resistance R and the reactance X of the impedance Z_T , or easier still, it is only necessary to read R and X off a series of graphs. Actually, the ratio $\frac{V_1}{v_1}$ is for convenience expressed in decibels, and

a half wavelength from the input end of the line is more conveniently expressed as 180 electrical degrees, and marked off every degree. An analysis of the principles underlying this instrument is given in Appendix I, but its assimilation is not essential to the efficient operation of the set. In actual practice, certain components have to be added to the simple system described to compensate for imperfections caused by stray capacities and the finite length of the connector joining the unknown to the sliding point on the transmission line, and Figure 3 is a circuit of the actual instrument.

Referring to Figure 3, B is a battery test oscillator, which plugs into the end of the transmission line. Z_a is a tiny variable coupling condenser coupling the oscillator to the input of the transmission line. C is the stray capacity at the input to the transmission line, and L is a variable inductance, which can be brought to resonance with C, the combination forming high impedance shunt, which has little effect on the performance of the instrument, except under special conditions to be discussed later. If C were not tuned out, it would alter the electrical length of the line by some indeterminate amount and so introduce errors. Unwanted strays at the sliding point A are compensated for by means of a variable short-circuited line (nominally $1/4$ wavelength) sliding along with the unknown. The adjustment is such that this piece of line together with strays are equivalent to a very high impedance shunted across the unknown.

The main transmission line is of the concentric type about 38" long and 1-5/8" outside diameter with concentric polystyrene insulators separating the inner and outer conductors, and the whole is suitably mounted on a wooden base, which forms the lid of the box, into which the instrument can be packed when not in use. The scale can be slid along or removed by loosening the thumb screw on the clamp. A celluloid pointer extends down from the slider and a hairline on the celluloid indicates on the scale. A meter rule graduated in centimeters and millimeters is fixed to the base beside the special scale. The meter rule is used for indicating the positions of maximum and minimum in place of the scale, when the frequency has been altered from that marked on the scale. Wherever possible however, the scale should be removed and replaced by one marked for the frequency being used.

OPERATION.

Initial adjustments: (Initially done by manufacturer)

- (1) Connect a coaxial cable from the coaxial socket D (Fig. 4) to the input of the Field I intensity Receiver, which is tuned to the desired operating frequency and is switched to A.V.C. operation.
- (2) Fix in place the scale marked off for the desired operating frequency. Set the slider until the distance "P" between the two coaxial plugs is just a half wavelength (a convenient measure of a half wavelength is from 15 degrees to 15 degrees on the scale, i.e. 180 degrees separation). Then without moving the slider, slide the scale until the hairline reads 180 degrees and then clamp the scale down by turning the thumb screw.
- (3) Attach a half wavelength of coaxial cable to coaxial connector E, and short circuit the far end of this half wave piece.
- (4) Attach the Battery Test Oscillator to the end of the line (being careful that the line is registering properly in the inlet of the test oscillator), adjust the oscillator to the desired frequency, and switch it ON.
- (5) Slide the slider until a minimum output is registered on the receiver. If the scale then reads less than 180 degrees, the external piece of short-circuited line (nominally half wave-length) is too long and it should be shortened until the minimum falls at 180 degrees on the scale. If, at first, no indication is obtained in the receiver, it usually means that transmitter and receiver are not tuned to the same frequency. To remedy, set the slider to approx. 90 degrees on the scale and tune the receiver until a maximum indication is observed. Then proceed as above.
- (6) When adjustment 5 has been correctly made, slide along till the pointer indicates exactly 90 degrees, and unlock and adjust the set screw F until a maximum reading is indicated on the receiver output. Relock set screw.
- (7) Without altering anything else, remove the short

circuit from the external piece of line (half wave nominal) and adjust the length of the short-circuited piece of line (nominally $1/4$ wave) which is attached to the slider and concentric with the main transmission line. This is done by loosening the two round head screws and sliding the telescopic piece, without altering the slider, the adjustment being made until a minimum reading is obtained on the receiver output. Tighten up the screws.

(S) If the slider is now shifted a maximum output should be obtained when the pointer reads 180 degrees. A further check is now made by short-circuiting the external half wave piece again, when a minimum should be obtained at 180 degrees, and a maximum at 90 degrees. Remove the short circuit.

Impedance Measurement.

1. By decibel and θ graphs:

The instrument is now ready for impedance measuring use, the unknown being connected to the instrument by medium of the adjusted half wave piece for greatest accuracy. This is, of course, due to the fact that the input impedance of a half wave line is equal in magnitude to the terminating impedance, and hence the finite length of the coaxial connector the slide point is prevented from introducing errors. It is advisable to have the switch on the "A.V.C." position to commence with, but if the difference "S" is less than 10 dB. a more accurate reading can be obtained by switching to "Manual." The process consists in switching to "A.V.C." then sliding the slider until a maximum output reading is indicated on the receiver. Note this reading on the decibel scale of the meter for example 43dB, and note also the reading " θ " of the hairline on the degree scale, in this case 180°. Slide again until a minimum is indicated on the receiver (it should be 90 degrees from the maximum), and again note the decibel reading, i.e. 28 DB. Take the difference "S" between the two decibel readings, i.e. 15 DB and find the corresponding curve on the resistance chart. Then the resistance R is the ordinate on this curve corresponding to θ degrees (abscissae). The reactance, X, is found in exactly the same manner by finding the curve on the reactance chart corresponding to "S" decibels, and reading off the ordinate for an abscissae of " θ " degrees. If the impedance is required it is calculated by taking the square root of the sum of the squares of the resistance (ohms) and reactance (ohms).

EXAMPLE 1

$\theta = 180^\circ$	Max. DB reading = 43
	Min. " " = 28
	"S" = 15

referring to the resistance curve when $\theta = 180^\circ$ and "S" = 15 then R = 200 ohms. Referring to the reactance curve when $\theta = 180^\circ$ and "S" = 15 then X = 0. then Z is a pure resistance of 200 ohms.

EXAMPLE 2

In this example switch set at manual

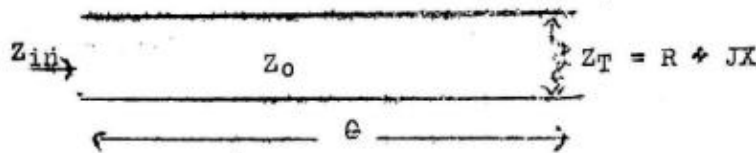
X is inductive (positive) If θ is between 90 and 180 degrees X is negative (capacitive).

Further points in connection with operation:

The adjustments Z_a (coupling to oscillator) and C_1 (coupling to receiver) will have normally been made before the instrument leaves the manufacturer. The latter becomes accessible by removing the cap G, which is held by a piece of chain. For greatest accuracy of impedance measurement, the plates of this tiny condenser should be not less than 1/4" apart. The adjustment Z_a is the set screw H, and this is inserted into the oscillator box, so that the test oscillator must be removed to adjust it. Its adjustment is such that with the maximum possible impedance being indicated (namely Z_T a short circuit and the slider at 90 degrees) the receiver output reading should be at a convenient point on the meter, such as 3/4 full scale. During operation it is wise to frequently check that the receiver is on frequency by tuning for maximum output, particularly after large changes of input. It is often convenient to switch from A.V.C. to manual on the receiver in order to get sharp maximum and minimum indications and so determine θ more accurately. If a half wave piece is not available for connecting to the unknown, it is permissible, but with slightly lessened accuracy, to connect the unknown direct to the coaxial outlet on the slider.

IMPEDANCE MEASURING SET.

APPENDIX I



The input impedance of a loss free line of characteristic impedance Z_0 and termination impedance $Z_T = R + jX$ is

$$Z_{in} = Z_0 \frac{Z_T \cos \theta + j Z_0 \sin \theta}{Z_0 \cos \theta + j Z_T \sin \theta} = Z_0 \frac{R \cos \theta + j(X \cos \theta + Z_0 \sin \theta)}{(Z_0 \cos \theta - X \sin \theta) + j R \sin \theta} \quad \dots(1)$$

$$1/Z_{in}^2 = Z_0^2 / \frac{R^2 \cos^2 \theta + (X \cos \theta + Z_0 \sin \theta)^2}{R^2 \sin^2 \theta + (Z_0 \cos \theta - X \sin \theta)^2} \quad \dots(2)$$

Differentiating (2) with respect to θ , equating to zero, and simplifying, we find that the condition for maximum or minimum

$$Z_{in} \text{ is } \tan 2\theta = \frac{2 X Z_0}{R^2 + X^2 - Z_0^2} \quad \dots(3)$$

Equation (3) has an infinite number of solutions for 2θ , each successive one being 180 degrees greater than the previous, and alternate solutions are for maximum and minimum values of Z_{in} . Actually only the first two or three solutions are of interest, and it is obvious that the value of θ for Z_{in} (maximum) is exactly 90 degrees different from that for Z_{in} (minimum). This is the first important and well known conclusion.

Rationalizing (1) and substituting (3) in it we get -

$$\begin{aligned} Z_{in} \text{ (max. or min.)} &= \frac{Z_0^2 R}{(X^2 + R^2 - Z_0^2) \sin^2 \theta - X Z_0 \sin 2\theta + Z_0^2} \\ &= \frac{Z_0 R}{-X \tan \theta + Z_0} \quad \dots 4 \end{aligned}$$

Note that the imaginary term has vanished from (4) which means that this maximum or minimum value of Z_{in} is a pure resistance. This is the second important and well known conclusion. Further it is obvious from (4) that if X is a positive reactance, the maximum Z_{in} occurs when θ is less than 90 degrees. Also, if X is a negative reactance, the maximum occurs when θ is between 90 and 180 degrees.

Let θ_1 be the value of θ , when Z_{in} is a maximum. Call it Z_{in} .

Let θ_2 " " " " " " " " minimum. Call it Z_{in} .

$$\text{Let } k^2 = \frac{Z_{in}}{Z_{in}} \dots (5)$$

and $\tan \theta_1 = - \frac{1}{\tan \theta_2}$... since θ_1 and θ_2 are 90° different

$$\text{and } Z_{in} = \frac{Z_0 R}{Z_0 - X \tan \theta_1} \quad Z_{in} = \frac{Z_0 R}{Z_0 - X \tan \theta_2}$$

$$\therefore \frac{Z_{in}}{Z_{in}} = \frac{Z_0 - X \tan \theta_2}{Z_0 - X \tan \theta_1} = k^2$$

$$\therefore k^2 = \frac{Z_0 + \frac{X \tan \theta_1}{Z_0 - X \tan \theta_1}}{\dots} \text{ and rearranging } X = \frac{Z_0 \tan \theta_1 (k^2 - 1)}{1 + k^2 \tan^2 \theta_1} \dots (6)$$

$$\text{Now } Z_{in} \cdot Z_{in} = \frac{Z_0^2 R^2}{(Z_0 - X \tan \theta_1)(Z_0 + \frac{X \tan \theta_1}{\tan \theta_1})} = \frac{Z_0^2 R^2}{-X^2 + Z_0^2 + \frac{2XZ_0}{\tan 2\theta}} = Z_0^2 \dots (7)$$

Thus the geometric mean of maximum and minimum impedances is Z_0 .

This is a well known conclusion.

$$\text{From (5) and (7) } Z_{in} = \frac{Z_0}{k} \text{ i.e. } \frac{Z_0 R}{Z_0 + \frac{X}{\tan \theta_1}} = \frac{Z_0}{k}$$

Rearranging and substituting (6) for X -

$$R = Z_0 \frac{k(1 + \tan^2 \theta_1)}{1 + k^2 \tan^2 \theta_1} \dots (8)$$

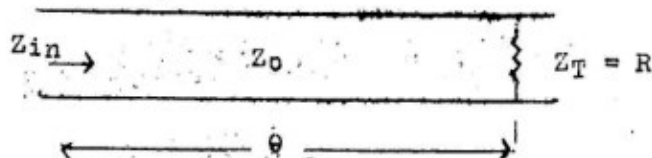
From equations (6) and (8) the series of graphs supplied with the instrument have been calculated. For example, with the 6 db curve $k^2 = 2$ and $Z_0 = 85$ ohms. Then R and X are calculated for a series of values of θ_1 from 0 to 180° and the curves plotted. Then other decibel values are selected and the whole process repeated.

Special case of pure reactance, i.e. $R = 0$.

$$\text{From (8) } K = \infty \text{ when } R = 0 \text{ then from (6) } X = \frac{Z_0}{\tan \theta_1} \dots (9)$$

Hence if X is positive maximum occurs when θ less than 90°
 " " X is negative " " " θ between 90° and 180°

APPENDIX 2 - RESONANCE METHOD.



CASE A When $R \ll Z_0$.

Then when $\theta = 180^\circ$ $Z_{in} = R$.

Then if θ is reduced to $180^\circ - d\theta$ the input impedance will increase. If it increases 3 decibels $|Z_{in}|$ now equals $\sqrt{2} R$.

$$\therefore \sqrt{2} R = Z_0 \sqrt{\frac{R^2 + Z_0^2 \tan^2(180 - d\theta)}{R^2 + R^2 \tan^2(180 - d\theta)}} = Z_0 \sqrt{\frac{R^2 + Z_0^2 \tan^2 d\theta}{Z_0^2 + R^2 \tan^2 d\theta}}$$

Squaring and collecting terms $2\left(\frac{R}{Z_0}\right)^4 \tan^2 d\theta + \left(\frac{R}{Z_0}\right)^2 - \tan^2 d\theta = 0$.

$$\text{From which } \left(\frac{R}{Z_0}\right)^2 = \frac{-1 + \sqrt{1 + 8 \tan^4 d\theta}}{4 \tan^2 d\theta} \dots \dots \dots (1)$$

$$\approx \tan^2 d\theta \dots \dots \dots (2)$$

$$\text{i.e. } R \approx Z_0 \tan d\theta \dots \dots \dots (3)$$

The error of this approximation is less than 1% if $\frac{R}{Z_0} < .25$,

i.e. R less than 22.5 ohms.

$$\text{Approximating further } R \approx Z_0 d\theta \dots \dots \dots (4)$$

Two readings are usually taken one above and one below 180° ,

$$\text{then } R \approx Z_0 \tan \frac{\theta_1 - \theta_2}{2} \approx \frac{Z_0}{2} (\theta_1 - \theta_2).$$

CASE B When $R \gg Z_0$

$$\text{Then when } \theta = 90^\circ \quad Z_{in} = \frac{(Z_0)^2}{R}$$

Then if θ is reduced to $90^\circ - d\theta$, the input impedance will increase. If it increases 3 db $|Z_{in}|$ now equals

$$\sqrt{2} \frac{(Z_0)^2}{R}$$

$$\therefore \sqrt{2} \frac{Z_0^2}{R} = Z_0 \sqrt{\frac{R^2 + Z_0^2 \tan^2(90 - d\theta)}{Z_0^2 + R^2 \tan^2(90 - d\theta)}} =$$

$$Z_0 \sqrt{\frac{R^2 + Z_0^2 \cot^2 d\theta}{Z_0^2 + R^2 \cot^2 d\theta}}$$

Squaring and collecting terms $\left(\frac{Z_0}{R}\right)^2 \cot^2 d\theta + 2 \left(\frac{Z_0}{R}\right)^4 - 1 = 0$

From which $\left(\frac{Z_0}{R}\right)^2 = \frac{-\cot^2 d\theta + \sqrt{\cot^4 d\theta + 8}}{4} =$

$$\frac{-1 + \sqrt{1 + 8 \tan^4 d\theta}}{4 \tan^2 d\theta}$$

$$\approx \tan^2 d\theta$$

and $R \approx \frac{Z_0}{\tan d\theta} \approx \frac{Z_0}{d\theta}$

Here again the first approximation is better than 1% when $R > 4Z_0$.

Two readings θ_1 and θ_2 are usually taken, one above and one below 90° .

then $R \approx \frac{Z_0}{\frac{\tan \theta_1 - \tan \theta_2}{2}} \approx \frac{2 Z_0}{\theta_1 - \theta_2}$

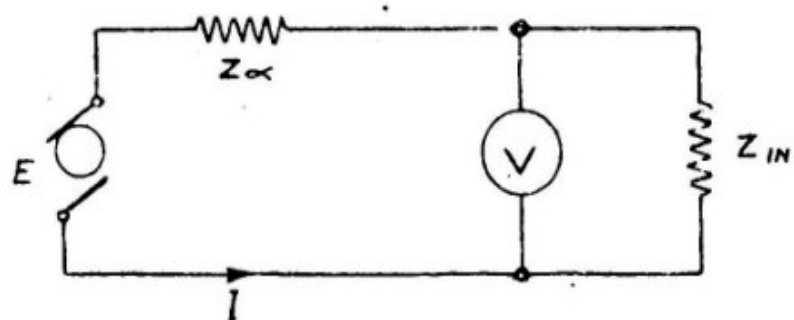


FIG. 1

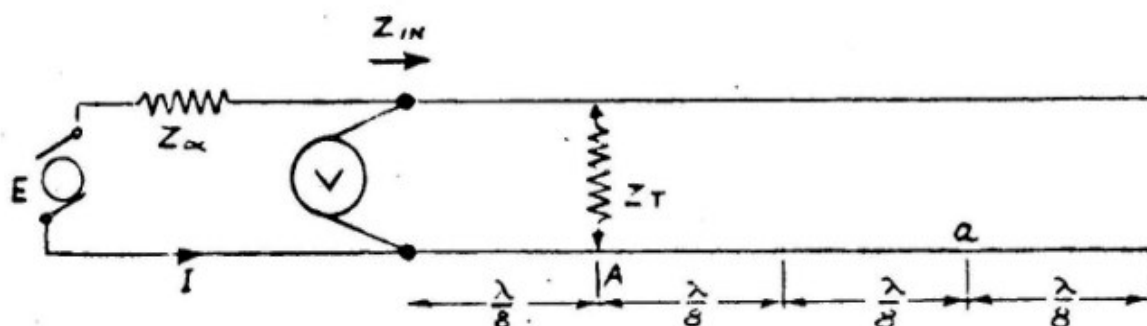


FIG. 2

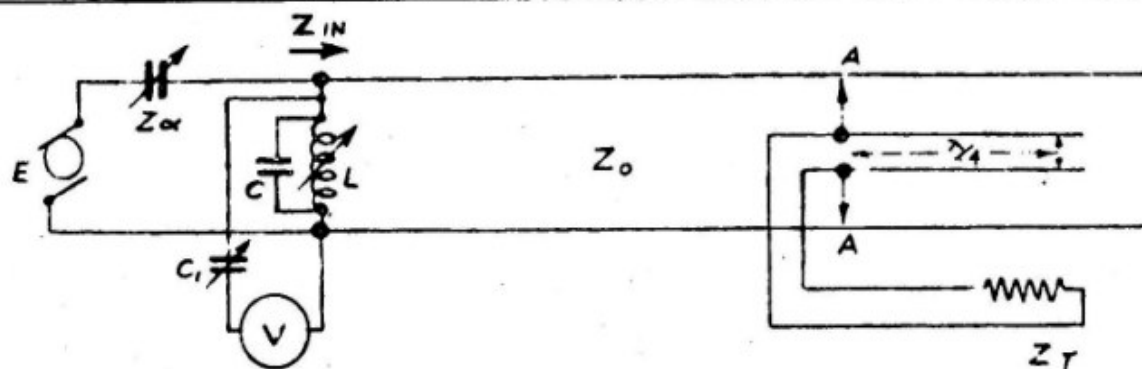


FIG. 3

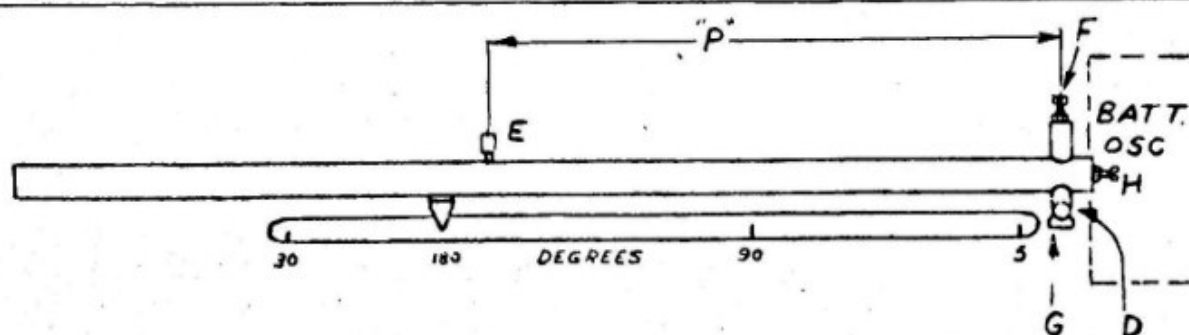
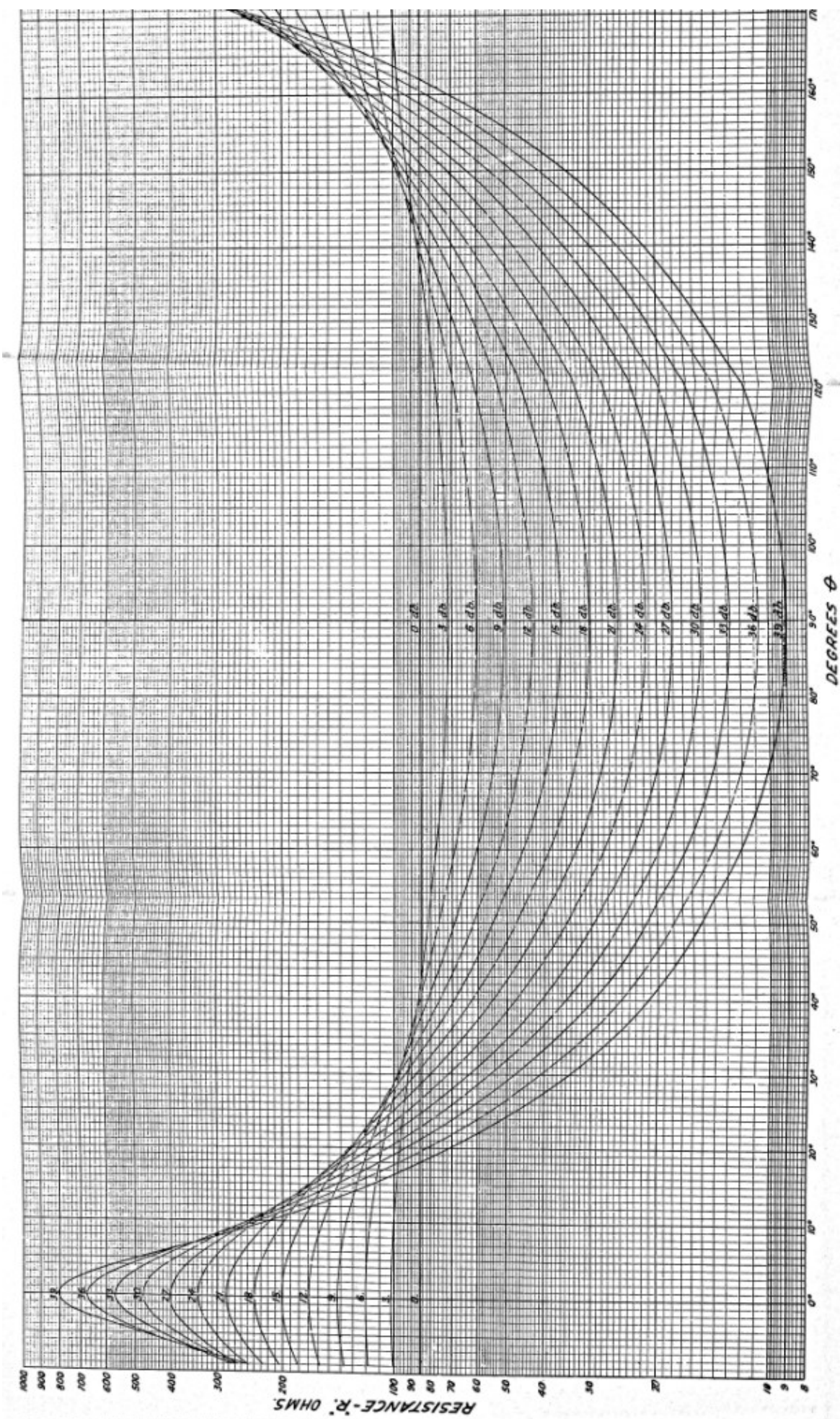
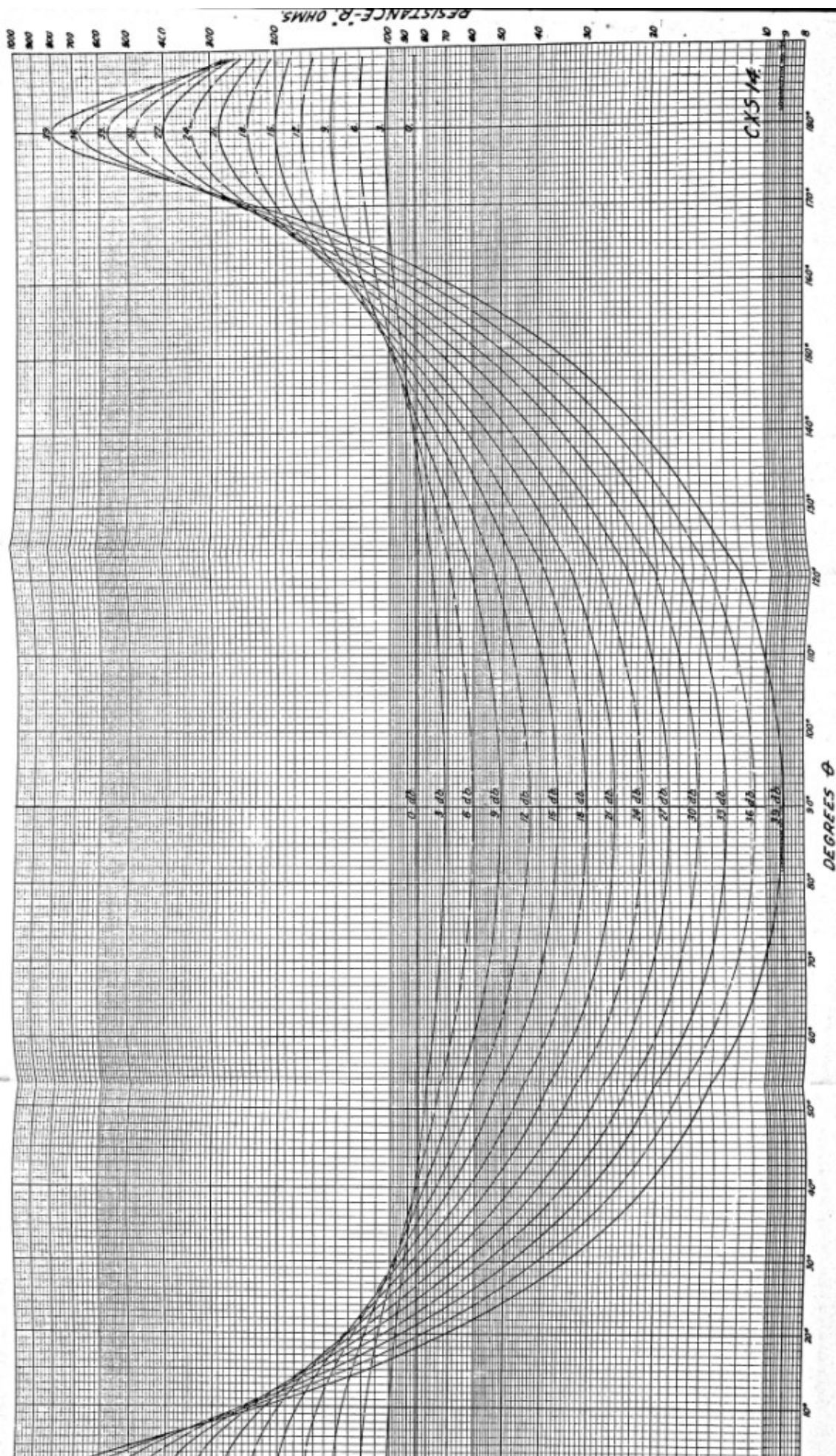
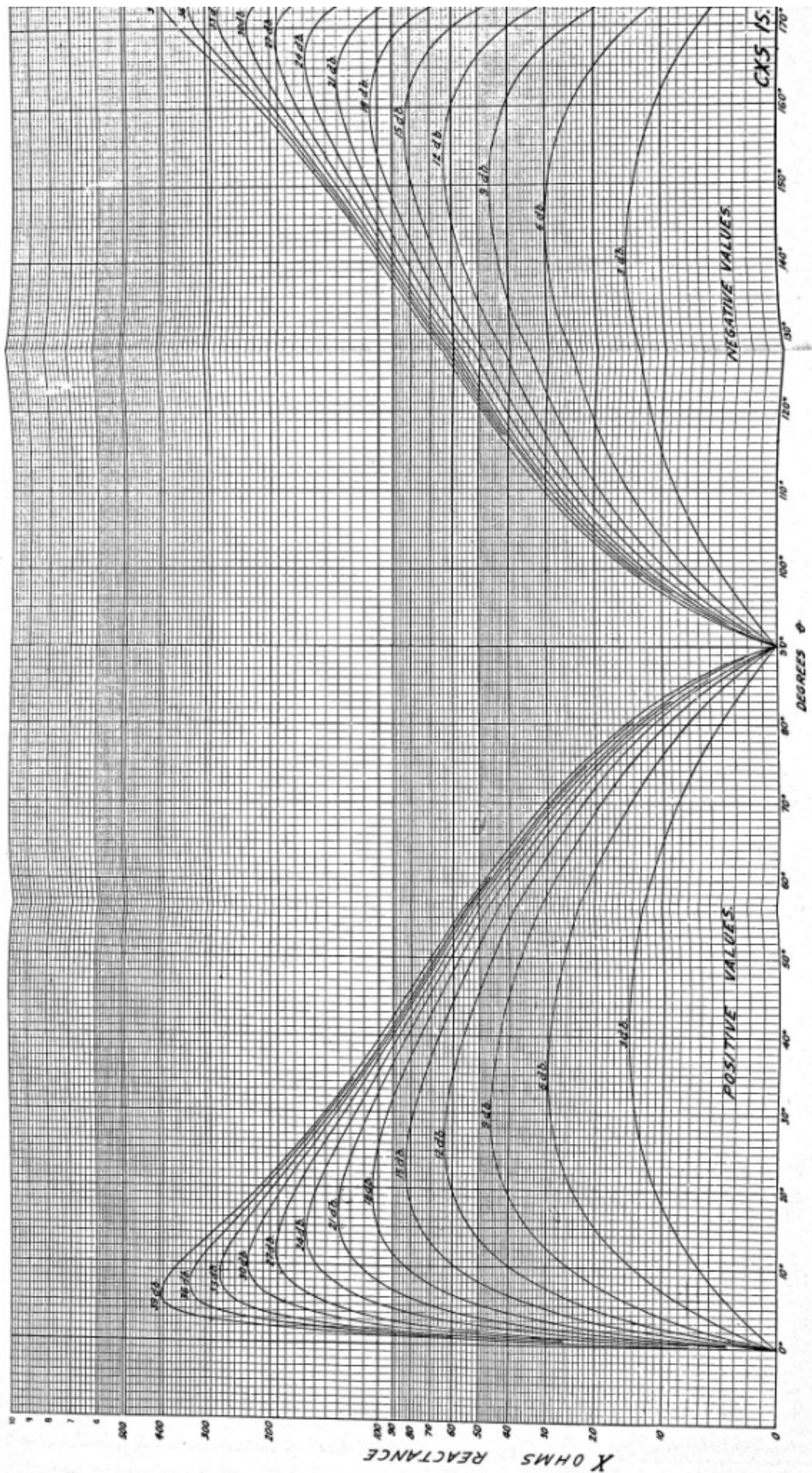
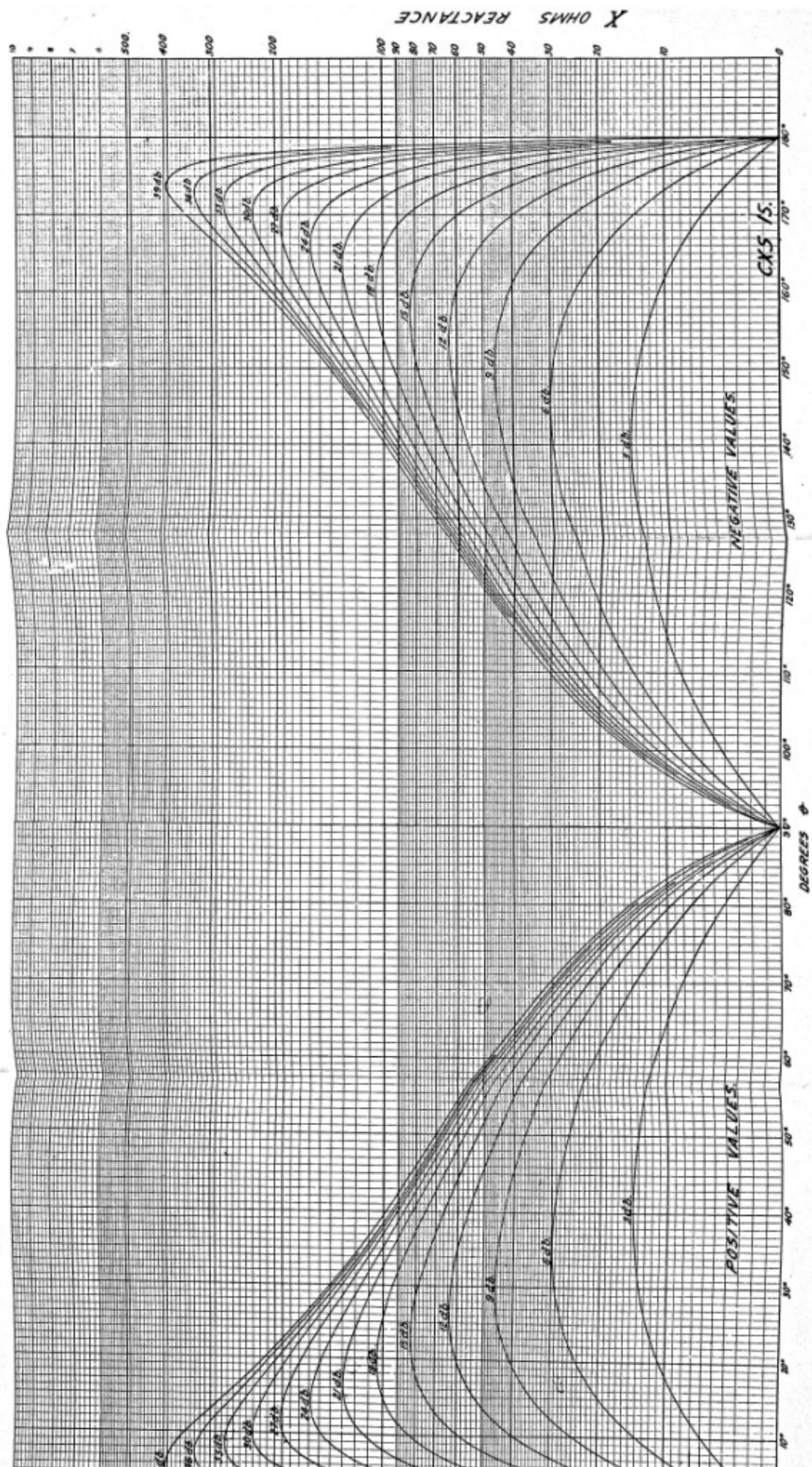


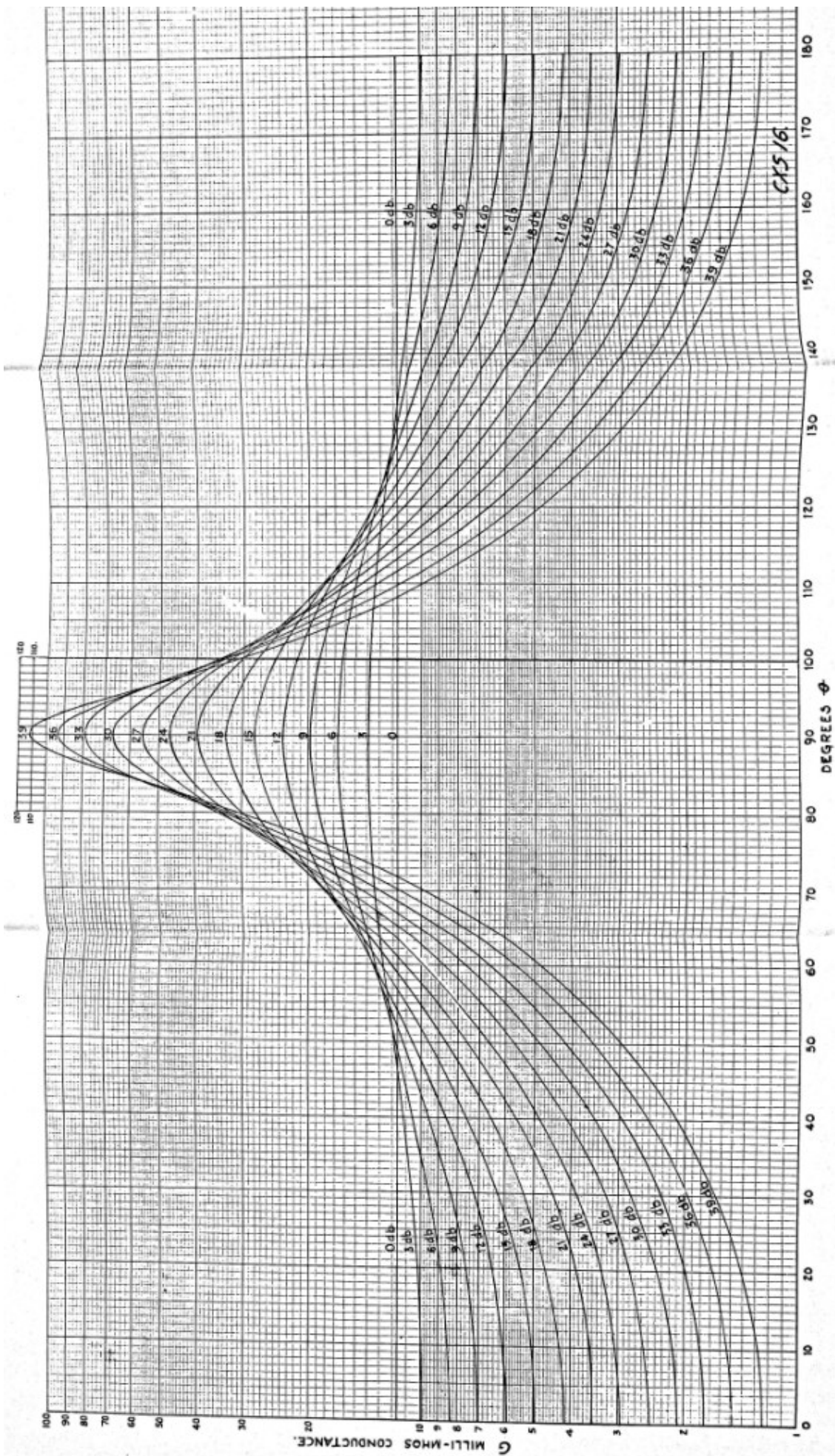
FIG. 4 D. AMPHENOL CONNECTOR TYPE 33 C MODIFIED
E. " " " " "

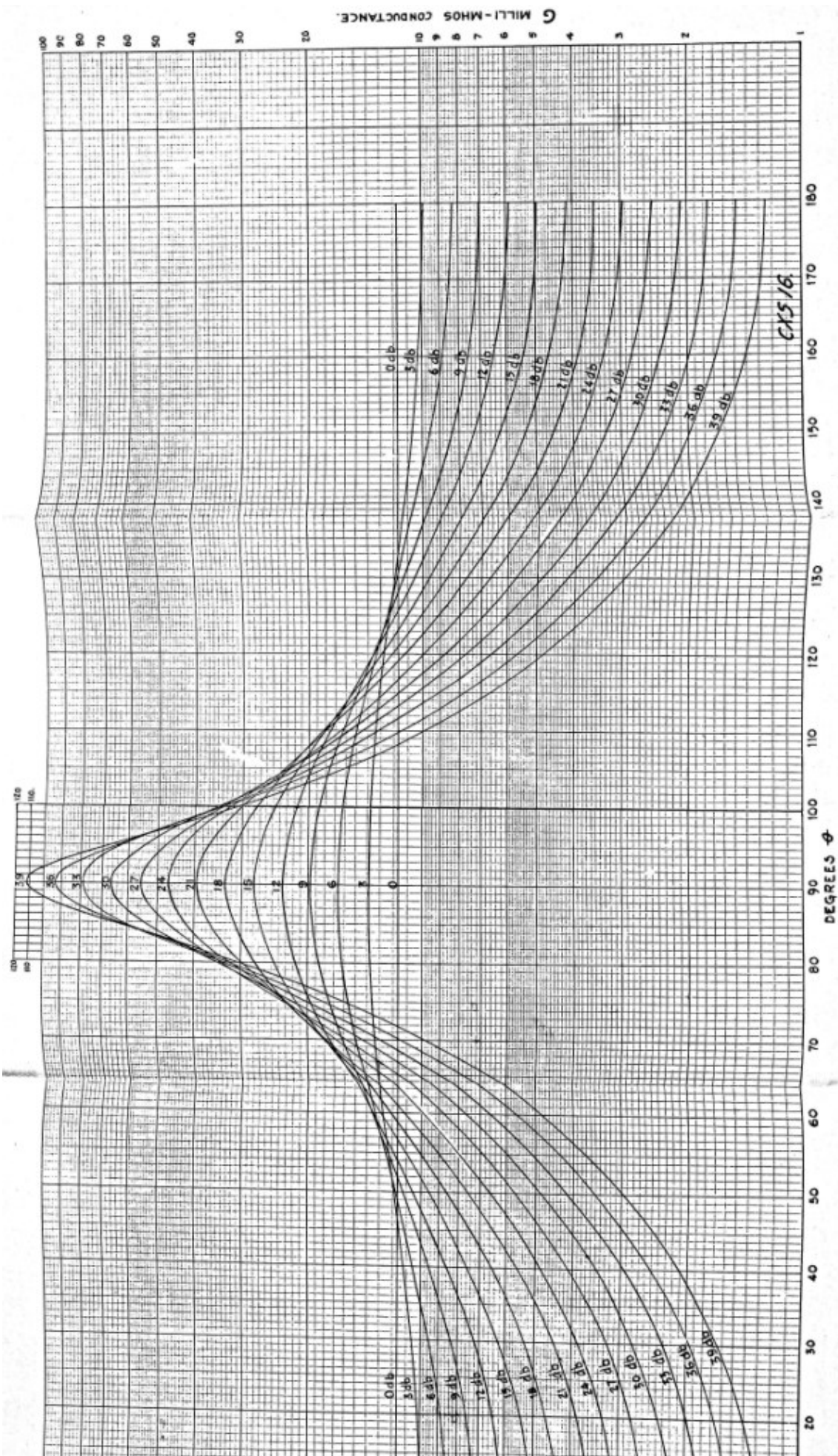


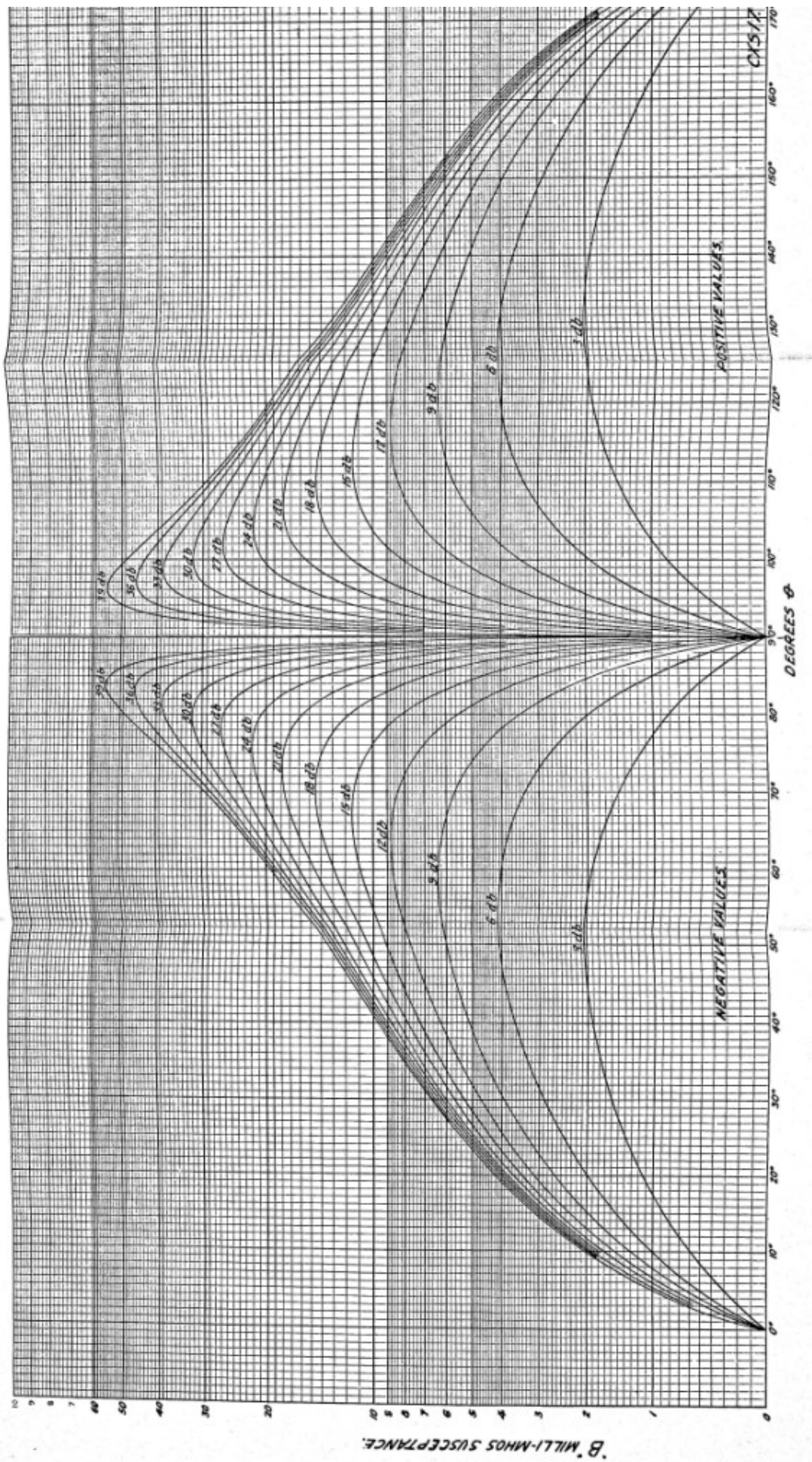




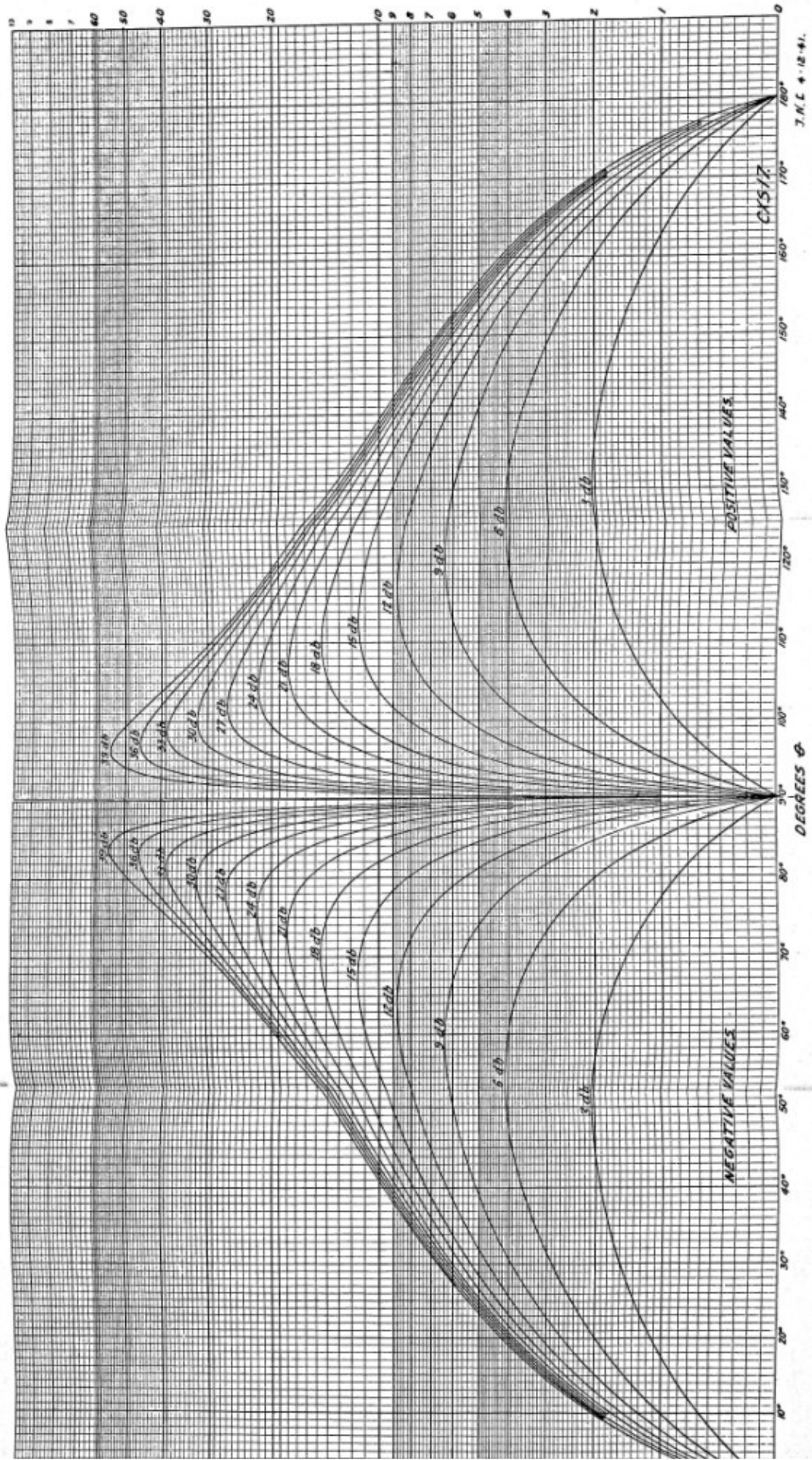








B* MILLI-MHOS SUSCEPTANCE



POSITIVE VALUES

NEGATIVE VALUES

T.N.C. + 12.41

R.D.F. TESTING EQUIPMENT
MONITORING CATHODE RAY OSCILLOGRAPH

(RD 14/42).

R.D.F. TESTING EQUIPMENT
MONITORING CATHODE RAY OSCILLOGRAPH

Service Designation

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" 2

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Fig. 1A

1B

2, 3, 4

5

(RD 14/42).

SERVICE DESIGNATION.

P.M.G. Unit T15 Oscillograph, Cathode Ray -
 Type M/D32 (Aust.)
R.A.N. - Patt. No. (Aust.) 223
A.M.F. - ZCA 4404
R.A.A.F. - Test Set type A9 Y1QS/60016
Serial No. -

SPECIFICATION OF CALIBRATOR AND TRIGGERED TIME BASE

(1) Output -

- A. Calibrator - Identical damped wave trains of frequency 500 kc/s. One for each input pulse
- B. Triggered Time Base - Exponential time base voltage, the voltage variation with time being such that the spot moves across the screen of a 906 C.R. oscillograph at a velocity of 1" per 24, 12 or 6 microseconds in the first inch as selected by a three position switch. One forward excursion of the spot across the screen is made for each input pulse.

(2) Input (common to calibrator and time base) -

Positive or negative pulse or square wave applied at "Triggering Pulse" terminal (Fig.4). With pulse input, "triggering Pulse" switch (S6, S7) is set according to the polarity of the applied pulse. With square wave input this switch selects the start of the time base and calibrating wave to be in synchronism with the positive or negative slopes of the square wave as desired.

(3) Adjustments -

- A. Calibrator - C20A (Figures 1A and 3). Screwdriver adjustment for setting calibrator to 500 kc/s.
- B. Calibrator and triggered time base. Screwdriver adjustment of R36A "triggered T.B. Length" (Figs. 1A and 4). Adjusts the length of the triggered time base.

(4) "Starting spot" and return trace "blackened out" from the time base.

SPECIFICATION OF THYRATRON TIME BASE.

(1) Output - Saw-tooth time base voltage.

(2) Input - Synchronising voltage at banana plug No. 3 "Cont. T.B. Sync." (Figs 1A and 3).

(3) Frequency of "saw-tooth" wave 25 to 50,000 c/s, continuously variable.

A. Coarse control - 7-position switch (S3... Fig. 1A and "Frequency Coarse"... Fig.2).

B. Fine control - Variable Resistor (R32A... Fig.1 and "Frequency fine"... Fig 2).

(4) Input control on synchronising voltage potentiometer.

meter (R30A, Fig. 1 and Fig. 2).

- (5) Thyatron bias control resistor (R31A, Fig. 1 and "884 bias" Fig. 4) screwdriver adjustment.
- (6) Gain control at output from time base amplifier (R35A on Fig. 1 and "AMP" on Fig. 2). Adjusts length of time base.
- (7) Circuit - 884 Thyatron gas discharge tube and 6J7G time base amplifier.

SPECIFICATION OF VIDEO AMPLIFIER

- (1) An amplifier inserted between "Y plate or video amp." terminal (Fig. 3) and the "Y" plate, when "Y selector" switch is in "vid-amp" position.
- (2) Voltage gain 4.5 to 1.
- (3) Frequency range - substantially linear from low audio frequencies to 1 mc/s. Hence suitable for faithful pulse amplification.
- (4) Valve - 6V6G.

SPECIFICATION OF U.H.F. RECTIFIER.

- (1) Input - Modulated (including pulse modulation) or unmodulated U.H.F. voltages.
- (2) Input impedance - 75Ω at coaxial socket No. 1 (Fig. 1). Socket marked "U.H.F. Diode" (Fig. 3).
- (3) Output -
 - A. Constant D.C. voltage equal to carrier peak if carrier unmodulated.
 - B. Video pulses if pulse modulated.
 - C. Other types of modulation will appear superimposed on a D.C. voltage (the rectified carrier).
- (4) Frequency characteristics - Will rectify short U.H.F. pulses without appreciable distortion.
- (5) Adjustment - Variable condenser (C5A Fig. 1 and C5A Fig. 3) Series resonant filter to keep U.H.F. off the C.R. oscillograph plates (screwdriver adjustment).

SPECIFICATION OF C.R. OSCILLOGRAPH...906

Controls -

- (1) Intensity (R33A Fig. 1 and "INTENSITY," Fig. 2)
- (2) Focus (R34A Fig. 1 and "FOCUS," Fig. 2)
- (3) "X" shift (R32B Fig. 1 and "X Shift" Fig. 2).
- (4) "Y" shift (R32C Fig. 1 and "Y Shift" Fig. 2).
- (5) "X" plate switch (S4, S5 Fig. 1 and "X Selector," Fig. 2). This is a three position switch which connects the "X" plate of the C.R.O. through a condenser to -

- A. Banana socket (Banana socket No. 2, Fig.1, and "X" plate, Fig. 4):
- B. To triggered time base output.
- C. To thyatron time base output.

The three positions of the switch are designated respectively "EXT.", "TRIG'D. T.B.", and "CONT. T.B

- (6) "Y" plate switch (S1, S2, Fig.1, and "Y selector," Fig.2). This is a four-position switch which connects the "Y" plate of the C.R.O. to -

- A. (Banana socket No. 1 and coaxial socket No.2 Fig.1) marked "Y plate or vid. amp." (Fig.3).
- B. Rectified output from U.H.F. diode.
- C. Output from video amplifier
- D. Output from calibrator.

The four positions of the switch are designated respectively "EXT.", "U.H.F.", "Vid. AMP.", and "CAL. OSC."

- (7) Adjustments.

Variable condensers (C5B and C5C, Fig.1) Series resonant filters on the plates of the C.R.O. to eliminate U.H.F. They are screwdriver adjustments accessible from the back of the instrument after the case has been removed.

SPECIFICATION OF POWER PACK (SEPARATE UNIT).

- (1) Supply (input) 220-240 or 260 volts 50 c/s (Fig.5).
- (2) Output (two independent power packs on the same chassis) -
 - A. 906 anode supplies - 750, 1300 or 1900 volts as selected by a three-position switch.
 - B. 350 volts 100 M/A D.C. anode supply.
 - 6.5 " 4 amps A.C. heater supplies.
 - 2.5 " 2.5 amps heater supply for 906
- (3) Interconnection - (between power pack and oscillograph):
 - A. 906 heater supply and negative lead of 906 anode supplies by means of a shielded 3-core cable ending in an A.W.A. 3-pin female plug at the C.R.O.
 - B. Remainder of supply (including positive lead of 906 anode supply) by means of a 5-core shielded cable ending in an A.W.A. 8-pin female plug at the C.R.O.
- (4) Selection of mains input tap -
 - A. First pack - by means of 3-position "amphenol" switch selecting 220, 240, or 260 volt tap.
 - B. Second pack - by means of 3-position "amphenol" switch selecting 220, 240 or 260 volts.

Both switches accessible by removing pack from case.

(5) Panel controls -

A Three-position switch selecting 750, 1300 or 1900 volt 906 supply.

B Mains On-Off switch.

(6) Valves -

879 1 off

5V4G 1 off

Total Valves for C.R.O.

6V6G 2 off

1852 2 "

EA50 1 "

884 1 "

6J7G 1 "

6H6 1 "

906 1 "

INTRODUCTION

It will be seen that T.15 is a multipurpose instrument, and the following are some of the uses to which it may be put:-

- (1) As a normal cathode ray oscillograph with a linear time base, or external time base. "Y" amplifier is available if desired. The uses of such an instrument are too numerous to be listed.
- (2) By means of a built-in U.H.F. diode rectifier, the envelopes of strong U.H.F. signals can be viewed. The time base can be synchronised to the modulation of the carrier if a separate synchronising voltage is available along with the U.H.F. carrier.
- (3) Video pulses can be viewed with or without the use of the built-in video amplifier. In this case the time base can be readily synchronised.
- (4) If a synchronising pulse or square wave is available the triggered time base can be used in conjunction with the "Y" plate direct, the video amplifier, or the U.H.F. diode to view rapidly rising voltages such as video pulses in close detail. Further by comparing with the calibrator, the period of the pulse can be measured with reasonable accuracy. Without the use of an external high gain video amplifier weak video pulses will not be visible on the C.R.O. screen. A triggered time base is somewhat analogous to the firing of a bullet. As the trigger is pulled the bullet starts on its way almost instantaneously, and the oscillograph spot starts to fly across the screen almost instantaneously with the rise of the pulse. The whole process is repeated a sufficient number of times per second for the moving spot to appear as a straight line on the screen, except of course when a varying "Y" voltage is applied. The speed of the spot is varied with a three-position switch.

DESCRIPTION - CALIBRATOR AND TRIGGERED TIME BASE.

The positive pulse, negative pulse, or square wave is fed on to the grid of valve V2B(6V6G). The sudden impulse produces a surge of current in primary T1A, and hence a speedily rising pulse in its secondary. Depending on the polarity of the synchronising pulse, reversing switch (S6, S7) is operated to supply a negative pulse to the cathode of V6A diode. The diode conducts and the grids of V5A, V5B are driven rapidly negative. From here consider separately the calibrator and triggered time base action.

(1) Calibrator (V5B).

The plate current is cut off very rapidly, and as the current through L2A dislikes ceasing with such rapidity, its current continues to flow through condensers C.38 and C20A, thereby starting a damped train of oscillations, the first half cycle of which is positive.

Its frequency is adjusted to 500 kc/s by means of C20A, and it can be applied to the "Y" plate of the oscillograph by means of switch S2.

(2) Triggered time base (V5A).

The plate voltage of V5A is at a low value until its grid is driven negative. Then the valve becomes non-conducting and C17A, C18A or C9B (as selected by switch S8) charge up rapidly, their voltage variations being such as to give spot velocities of 1" per 6, 12 or 24 microseconds respectively when applied to the 906 "X" plate, to which it is taken by way of switch S4, S5. In addition the screen of V5A is not bypassed, so that simultaneously with the valve being driven negative and the start of the time base, the screen voltage rises, and so makes the grid of the 906 more positive and increases the intensity of the spot (since in this position of S4, the screen of V5A is connected through a condenser to the 906 grid). This in effect means that the spot is bright during its forward excursion, and dull at other times, thus providing an effective "black-out" of the return trace and "zero spot." When the pulse is removed the grids of V5A, V5B return to earth potential at a rate determined by the time constant of R25A + R36A and the valve input capacities etc. which are shunted across them. When the valve V5A returns to a conducting state, C17A, C18A or C9B discharge through the valve, and the spot starts on its return journey, "blackened out" of course, since the screen of V5A falls to its low voltage value. Then it is obvious that the period of the forward excursion of the spot (and hence the length of the time base) can be increased by increasing resistor R36A. Note that when the pulse is cut off no leakage occurs from the negative grids of V5A and V5B through diode plate 3 of V6A.

DESCRIPTION - THYRATRON TIME BASE.

Consists of an 884 gas triode V3A with input potentiometer R30A for regulating the amount of synchronising voltage applied to its grid, and condenser switch S3 and variable resistor R32A for altering the frequency of the time base. The time base is amplified by a 6J7G valve V4A, the output of which is regulated by a gain control potentiometer R35A; a preset control R31A is also provided for altering the cathode bias of 884. In the position shown in Fig. 1, C11A charges up through resistors R10A and R32A until V3A plate voltage reaches discharge point, when condenser C11A rapidly discharges